**CLAIMS**

1. A synchronous electrical machine comprising:
   -a stator (10); and
   - at least one rotor (20) having permanent magnets (21),

   characterized in that it is designed so as to have $X_d > X_q$,
   where $X_d$ is the direct reactance and $X_q$ is the quadrature reactance.

2. The machine as claimed in claim 1, characterized in that $X_d/X_q > 1.1$ and better still $X_d/X_q > 1.5$.

3. The machine as claimed in claim 2, characterized in that $X_d/X_q \simeq 3$.

4. The machine as claimed in any one of the preceding claims, characterized in that $X_qI_o/E$ is between 0.33 and 0.6.

5. The machine as claimed in any one of the preceding claims, characterized in that $X_dI_o/E$ is between 0.66 and 1.

6. The machine as claimed in any one of the preceding claims, characterized in that the stator (10) has teeth (11), each carrying at least one individual coil (12).

7. The machine as claimed in the preceding claim, characterized in that the teeth (11) of the stator (10) are devoid of pole shoes.

8. The machine as claimed in any one of the preceding claims, characterized in that the rotor (20) is a flux-concentrating rotor, the permanent magnets

(21) of the rotor being placed between pole pieces (22).

9. The machine as claimed in the preceding claim, characterized in that the pole pieces (22) of the rotor each have a face turned toward the stator (10), which face has a convex portion (24).

10. The machine as claimed in the preceding claim, characterized in that the convex portion (24) of a pole piece (22) has a radius of curvature of between 20% and 30% of the inside radius (R) of the stator.

11. The machine as claimed in the preceding claim, characterized in that the circumferential ends (25) of the convex portion (24) of a pole piece (22) are angularly offset relative to the permanent magnets (21) adjacent this pole piece (22).

12. The machine as claimed in the preceding claim, characterized in that the angular offset β of the circumferential ends (25) relative to the adjacent permanent magnets (21) lies:

- between $80°/n_{teeth}$ and $100°/n_{teeth}$, being especially about $90°/n_{teeth}$, for a machine in which the ratio of the number of stator teeth $n_{teeth}$ to the number of rotor poles $n_{poles}$ is 3/2 or which satisfies the relationship $n_{teeth}/n_{poles} = 6n/(6n - 2)$, where n is an integer greater than or equal to 2; and

- between $50°/n_{teeth}$ and $70°/n_{teeth}$, being especially about $60°/n_{teeth}$, for a machine that satisfies the relationship $n_{teeth}/n_{poles} = 6n/(6n + 2)$, where n is an integer greater than or equal to 2.

13. The machine as claimed in any one of claims 8 to 12, characterized in that each of the permanent magnets (21) of the rotor (20) lies radially set back from the circumferential ends of the convex portions (24) of the two adjacent pole pieces (22).

14. The machine as claimed in the preceding claim, characterized in that the setback (r) in the radial direction of the magnets (21) relative to the circumferential ends (25) of the convex portions (24) lies between 10% and 20% of the inside radius (R) of the stator (10).

15. The machine as claimed in any one of claims 8 to 14, characterized in that each of the pole pieces (22) of the rotor (20) has two shoulders (26), at least one permanent magnet (21) lying between the shoulders of two adjacent pole pieces (22).

16. The machine as claimed in any one of claims 8 to 15, characterized in that each of the pole pieces (22) of the rotor (20) has a salient part (27) extending toward the stator (10), having radial edges (28) that are angularly offset relative to the radially directed edges (29) of the permanent magnets (21) adjacent the pole piece (22).

17. The machine as claimed in any one of the preceding claims, characterized in that the permanent magnets (21) have, when the machine is observed along the axis (X) of rotation of the rotor, a cross section of elongate shape with its long axis lying in a radial direction.

18. The machine as claimed in any one of the preceding claims, characterized in that the permanent magnets (21) of the rotor (20) have, when the machine is observed along the axis (X) of rotation

of the rotor, a rectangular cross section with its large side oriented parallel to a radius of the machine.

19. The machine as claimed in any one of the preceding claims, characterized in that the stator (10) has 6n teeth (11) and the rotor (20) has 6n ± 2 poles (22), n being greater than or equal to 2.

20. The machine as claimed in any one of the preceding claims, characterized in that it has a single inner rotor.

21. The machine as claimed in any one of the preceding claims, characterized in that the power of the machine is equal to or greater than 0.5 kW.

22. The machine as claimed in any one of the preceding claims, characterized in that it constitutes a generator.

23. The machine as claimed in any one of claims 1 to 21, characterized in that it constitutes a motor.

24. An assembly comprising:

- a machine as defined in any one of claims 1 to 19, this machine constituting a synchronous motor; and

- a control device for controlling a synchronous motor, allowing the motor to operate at approximately constant power $P_o$ over a range of rotation speeds of the rotor, which includes a computer (45) designed to determine the direct current component $I_d$ and the quadrature current component $I_q$ of the motor supply current, the current component $I_d$ and $I_q$ being equal, to within 20%, better still to within 10% and even better to within 5%, to:

$$I_d \simeq i_d I_o \simeq -i \sin\alpha I_o \text{ and } I_q \simeq i_q I_o \simeq i \cos\alpha I_o,$$

where $I_o$ is the maximum intensity of the current imposed by the rating of the control device;

$$\alpha = \arctan\left(\frac{x_q(e-y)}{x_d \quad x}\right);$$

$$i = \sqrt{\left(\frac{x}{x_q}\right)^2 + \left(\frac{e-y}{x_d}\right)^2},$$ the unitary current flowing in one phase of the armature;

(x,y) being one of the real roots of the equations:

$$x^2 + y^2 = \frac{v^2}{m^2} \text{ and } y = e\left(1 - \frac{x_d}{x_d - x_q}\right) + \frac{p}{m} e \frac{x_d x_q}{x_d - x_q} \frac{1}{x};$$

m denotes the ratio of the rotation speed of the rotor to the base speed;

e is the ratio of, on the one hand, the electromotive force and, on the other hand, the product of m multiplied by the voltage $V_o$ imposed by the mains supply;

v is the ratio of the voltage across the terminals of one phase of the armature to the maximum voltage per phase $V_o$ imposed by the mains supply;

p is the ratio of the rms power to the power $P_o$;

$\alpha$ is the phase difference between the current and the electromotive force;

$x_d$ is the quotient $\frac{X_d I_o}{mV_o}$, $X_d$ being the direct reactance; and

$x_q$ is the quotient $\frac{X_q I_o}{mV_o}$, where $X_q$ is the quadrature reactance.

25. The assembly as claimed in the preceding claim, characterized in that the root (x,y) chosen is that which minimizes i.

26. The assembly as claimed in either of the two preceding claims, characterized in that it includes:

- a three-phase inverter (35); and
- a vector controller (37) designed to transmit, according to the current components $i_d$ and $i_q$, control signals to electronic switches (60) of the inverter (35).

27. A method of controlling a motor as defined in claim 23, in which:

- at least the supply voltage ($V_{DC}$) of an inverter connected to the motor and the rotation speed ($\Omega$) of the motor are measured; and
- the direct current components $i_d$ and the quadrature current components $i_q$ of the supply current for maintaining constant power for a given speed setpoint ($\Omega$*) above the base speed are determined by real-time calculation and/or by access to a register on the basis of at least the voltage $V_{DC}$ and the measured speed.

28. The method as claimed in either of the two preceding claims, characterized in that a torque setpoint t* is determined as a function of at least the difference between the measured rotation speed ($\Omega$) and the rotation speed setpoint ($\Omega$*) of the rotor.

29. The method as claimed in the preceding claim, characterized in that a power setpoint (p*) is determined as a function of at least the torque setpoint and the measured rotation speed.

30. The method as claimed in the preceding claim, characterized in that the direct current component $i_d$ and quadrature current component $i_q$ values are calculated in real time from the power setpoint,

the measured rotation speed and the DC supply voltage of the inverter.